

LEOWEB Version 11.0 User Manual

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June 2012

For nearly 50 years the Kansas Geological Survey (KGS) has been involved with developing computer programs to convert legal land descriptions to mapping coordinates. The first program was written in 1964 by Donald Good. His program used 126 land locations and an arbitrary map-coordinate system to test the possibility of using a computer to convert section, township, and range notation to Cartesian coordinates. Good's program was written in FORTRAN II for an IBM 1620 computer. Subsequent programs, such as KANS, developed by Charles O. Morgan and Jesse M. McNellis (1969) offered significant improvements, including the ability to calculate latitude and longitude values. KANS was written in FORTRAN IV and tested on an IBM 7040 at the University of Kansas Computing Center. The program utilized 948 latitude and longitude control points and 962 township and range correction parameters.

These early programs ran in a mainframe environment, making access to the general public impractical. With the advent of the PC, however, KGS employee Charles G. Ross (1989) saw an opportunity to write such a program. Ross named the program LEO, a play on words "LEGAL to GEO." In 1994 LEO II was released as a second generation version of the program. Subsequent development work was performed by David R. Collins with the release of LEO 3.4, LEO 3.6, and finally LEO 3.9 released in 1999. The DOS versions of LEO were written in FORTRAN 77 for IBM-compatible personal computers. They remained a popular tool for industry, researchers, and government for nearly 20 years.

In 2007 work began on a GUI version of LEO that would utilize the benefits of the more powerful yet low-cost computers. LEO 7.0 was developed by Glen Gagnon as a stand-alone desktop program written in Java. Released in 2008, it offers an intuitive graphic user interface, NAD27 and NAD83 conversion options, and batch processing capabilities. The application was designed to run on any system supporting the JAVA Runtime Environment (JRE 1.6). A key aspect of the LEO 7.0 design was the ability to de-couple the calculation engine from the GUI front end. When implemented in this fashion, the same engine used in the desktop version can be called within database environments, such as Oracle. This feature makes LEO very flexible and guarantees the same results in all environments.

Deployed as a web service, it is called thousands of times per day to perform location calculations on the KGS web site. The database implementation of LEO is powerful, yet many users continue to rely on the stand-alone version. One reason is the ability to operate untethered from network connectivity. At times, the freedom to work remotely in the field is essential but the stand-alone design has a downside. One major drawback is the need for sufficient computer skills to install JAVA. Another is the lack of a method for periodically updating the stand-alone versions with corrected coordinate values for section corners.

Web-based software and the advent of mobile computing have made it possible to implement a solution that streamlines use, runs remotely, and can update coordinates in a timely manner.

This document serves as the User Manual for the LEOWEB 11 application and is intended to assist users with various features of the program.

Application Overview:

LEOWEB 11 is a web-based application that converts Kansas Public Land Survey System (PLSS) legal land descriptions to geographic coordinates and vice versa. It represents the most recent development efforts in a series of computer programs designed to perform coordinate conversions. The project was funded by the Kansas GIS Policy Board and the Kansas Geological Survey (KGS). It is not a surveying tool and only provides approximate conversion values. The program serves a broad range of users, including industry, researchers, government agencies, and the general public. The primary goal of the project is to provide a web-based version of LEO that 1) leverages existing development work, 2) simplifies use, and 3) provides updated geographical information to a larger population of end users in a timely manner.

Key features of the web version include the following:

- 1) An Interactive tool to convert PLSS to Geographic and Cartesian coordinates.
- 2) NAD27/NAD83/WGS84 coordinate conversions to Township, Range, and Section (TRS).
- 3) Support for Multiple Latitude/Longitude input formats.
- 4) Conversion of TRS and footage to latitude/longitude coordinates.
- 5) Conversion of TRS and Quarter Calls to latitude/longitude coordinates.
- 6) Conversion of Universal Transverse Mercator (UTM) coordinates to TRS.
- 7) A REST web service.

The application has been tested on contemporary web browsers, including Internet Explorer, Firefox, and Chrome. Coordinates are submitted interactively through the use of the web site with the results being calculated and returned to the browser from the server via Oracle's Application Express (APEX 4.1) environment. The results are added to a list that can be downloaded from the web page as a CSV (comma separated values) file. A key component of the application is the underlying JAVA code that serves as the coordinate calculation engine. The code was derived from a stand-alone version of LEO still available today. It is through Oracle's APEX environment that the underlying JAVA code is leveraged by implementing PL/SQL procedures to connect the calculation engine to the web pages.

There are two distinct components to the project. LEOWEB offers an interactive web page for performing online coordinate conversion and a web service intended for accessing conversion algorithms via computer programs. The second method is referred to as a REST web service and renders data as XML documents. The scope of work for the project included the design, development, and implementation of the application and support documentation. The work was performed by KGS Senior System Analyst/Programmer Glen Gagnon and KGS Oracle Database Administrator Kurt Look. A link to the application can be found on the Kansas Geological Survey's web site at the following URL: <http://www.kgs.ku.edu/software/softwareIndex.html> .

Getting Started:

A basic understanding of latitude and longitude coordinates, geodetic reference datum, and the PLSS system is required to use the program properly. Fortunately a wealth of information on these subjects can be found on the Internet. The Survey's Public Information Circular 20, "[The public land survey system in Kansas](#)," by Daniel R. Suchy, is an excellent place to start. This paper can be found online at http://www.kgs.ku.edu/Publications/pic20/pic20_1.html.

System Requirements:

LEOWEB runs as an Oracle APEX application. It requires a web browser that supports JavaScript and adheres to W3C standards for HTML and CSS. The application has been tested on multiple versions of Microsoft Internet Explorer, Mozilla Firefox, and Google Chrome.

Running the Program:

The LEOWEB application can be found on the Kansas Geological Survey's website at the following URL: <http://www.kgs.ku.edu/software/softwareIndex.html>.

Upon navigating to the web page the user is presented with the display panel depicted in figure 1. At this point you could convert a latitude/longitude pair to PLSS values by entering coordinates into the text fields and pressing the Submit button. There are a total of nine tabbed panels; six are for coordinate conversions and three for informational purposes. This document considers each panel, but first we should highlight some key program features.

Figure 1. Default display panel for LEOWEB 11.

Screen Layout:

Each page can be divided into two key regions. One region is for navigation and the other for content. The navigation region is at the top of each page. It shows a tabbed menu bar used to select the conversion options. Once clicked, a tab is highlighted and the corresponding page is rendered. As the user moves from tab to tab, a brief description of the required input parameters is revealed in the header of the content region. For example, when selecting **TRS_FT**, the message, “Enter Township Range Section and Footage values” is displayed.

The content region below the navigation bar is a combination of input fields and an area for showing conversion results. Common to all conversion pages is the requirement for specifying a **Datum** and reference **Corner**. A datum is a reference frame that defines the earth as a geometric model. LEOWEB datum options are NAD27, NAD83 and WGS84. The reference corner is used to determine the offset footage of the spot with respect to the section boundaries. Dropdown lists are used for selecting the Datum and reference Corner on all of the LEOWEB conversion pages.

Input field text boxes lie just below the drop down lists. These parameters will vary, depending on the type of conversion that is being requested. After entering the conversion values the user can click on the **Submit** button and the results will be displayed in the **Result String** text area. The results are also added to a list in the interactive report sub-region where the results can be customized using features of the built in “Actions” tool. (See figure 2.)

Navigation Region: LEOWEB V11.000

Content Region: Enter Township Range Section and Footage values.

Datum: NAD83 Corner: SE Session No: 4113670350103855

Township: 1 South Range: 1 Range Direction: East Section: 3

Footage NS: 2400 EW Footage: 2155 Offset Direction: (North of the South section line and west of East section line.)

Results String: Input TRSF = 01S01E03 Offset 2400 ft N of the South line, 2155 ft W of the East line.
DD Lat: 39.994724 Long: -97.3021 Datum: NAD83
Kansas TRS: 01S01E03

Township: 1S Range: 1 E Section: 3
Spot Footages from SE Corner: 2400 N 2155 W
Spot: Center of NE NW NW SE

Section is approximately 611 acres
Length of north line = 5304 Ft
Length of south line = 5310 Ft

Interactive Report Sub-Region: Submit, Q, Go, Actions

Latitude	Longitude	Datum	TRS	Footage NS	Footage EW	Footage Corner	Township	Township Direction	Range	Range Direction	Section
39.994724	-97.3021	NAD83	01S01E03	2400	2155	SE	1	S	1	E	3
39.992237	-97.279848	NAD83	01S01E02	1500	1200	SE	1	S	1	E	2
39.988928	-97.25893	NAD83	01S01E01	330	660	SE	1	S	1	E	1

Figure 2. Navigation and Content regions and key interactive areas.

Interactive Help:

Help has been added to all of the interactive screen objects. This includes the dropdown lists, input textboxes, and radio buttons. For help on any object, simply click on the label that corresponds to the object (i.e. click on the word Latitude). A help dialog box will appear with information associated with the object including acceptable min/max values. (See figure 3)

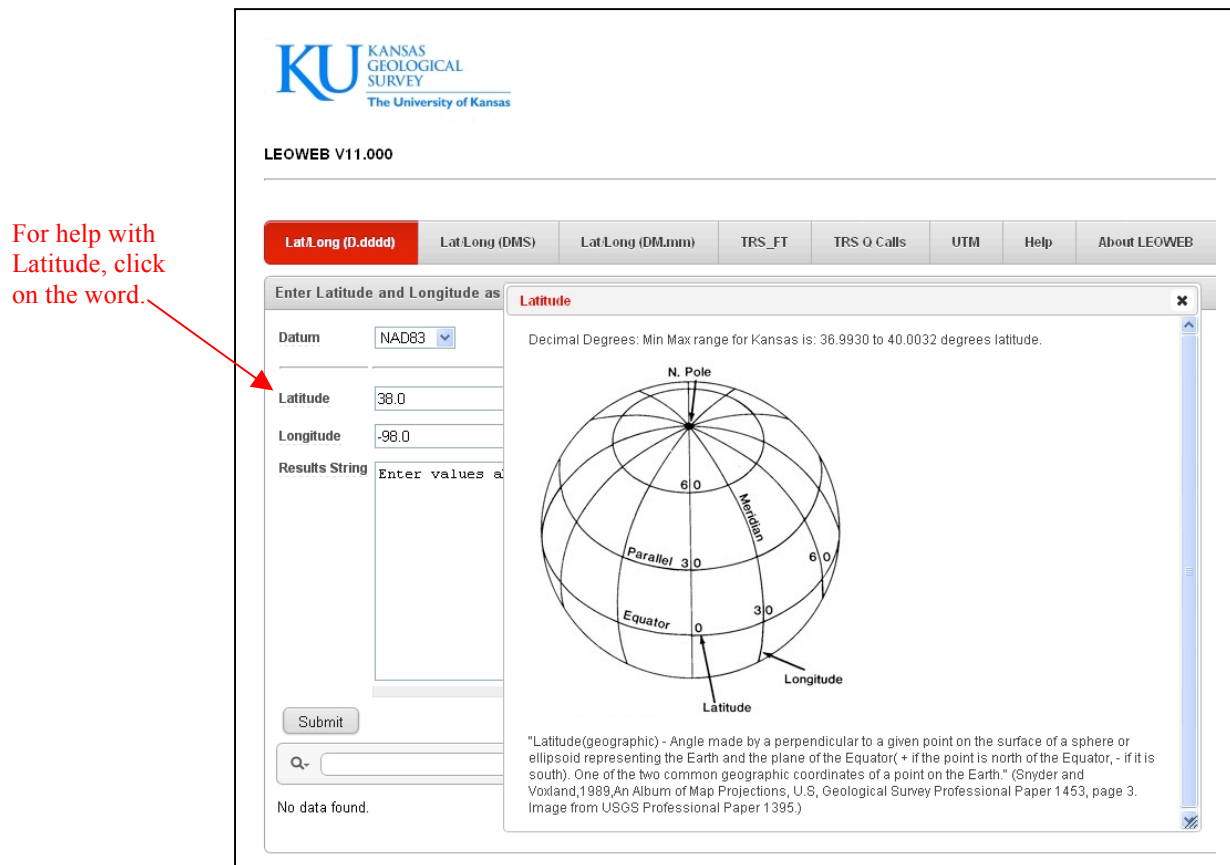


Figure 3. Help is available on all interactive objects.

Interactive Report:

A rich set of reporting tools is presented by clicking on the "Actions" button. The interactive features allow the user to customize the data records stored in the result set. The user can search for specific records, select display columns, filter and sort the data, alter the report layout, and download the data to the end-users computer. These features are made available using the "Search" bar depicted in figure 4. Detailed examples on how to use these features are presented later in this document.

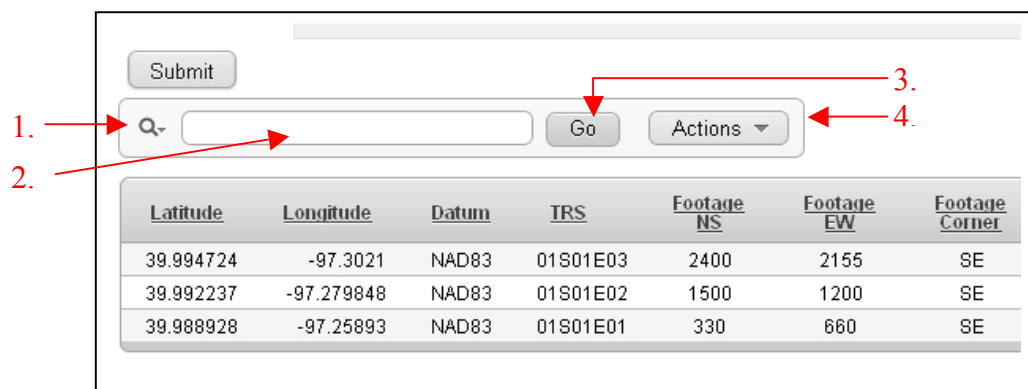


Figure 4. The interactive report tools are accessed via the Search bar which features; 1) Search by column, 2) Input text field, 3) Go button, 4) Actions Menu.

Conversion Options:

LEOWEB provides six routines for coordinate conversion:

- 1) Convert decimal degree latitude/longitude coordinates to TRS values.
- 2) Convert degree, minutes, and seconds latitude/longitude coordinates to TRS values.
- 3) Convert degree and decimal minutes latitude/longitude coordinates to TRS values.
- 4) Convert TRS and footage values to latitude/longitude coordinates.
- 5) Convert TRS and quarter call values to latitude/longitude coordinates.
- 6) Convert UTM coordinates to TRS values.

Coordinated conversion options can be performed using the interactive web pages or through the REST web service. Both methods require the same input parameters; however, the output results vary slightly between the two methods (see Table 1). The difference has to do with how the data are accessed, utilized, and rendered. Interactive users generally have only a few coordinates to convert at one time. In this scenario the results are displayed on the screen and written to a grid that can be downloaded as a CSV file. Once downloaded, the file can then be opened in a spreadsheet such as Microsoft Excel. With the REST service, the data are accessed by a computer program and the results are returned as XML (tag-formatted information).

Examples of the REST service and XML are given later in this document. However, a detailed discussion of these subjects is beyond the scope of this paper. For those interested, the W3School has an XML tutorial at <http://www.w3schools.com/xml/default.asp> and IBM hosts a web page on Rest Services at <http://www.ibm.com/developerworks/webservices/library/ws-restful>.

Table 1 - LEOWEB interactive versus REST output values.

Parameter Name (Description)	Data Type	Web Page	Rest Service
Version	Number	No	Yes
TRS (Township, Range, and Section string - i.e 16S24W11)	Character	Yes	Yes
Latitude	Number	Yes	Yes
Longitude	Number	Yes	Yes
Datum	Character	Yes	Yes
Township	Number	Yes	No
Township Direction	Character	Yes	No
Range	Number	Yes	No
Range Direction	Character	Yes	No
Section	Number	Yes	No
Footage NS (North or South distance to section line in feet)	Number	Yes	Yes
Footage EW (East or West distance to section line in feet)	Number	Yes	Yes
Footage Corner (Reference corner for offset footages)	Character	Yes	Yes
Spot	Character	Yes	Yes
QCall (REST tag i.e. <QCALL>SW NW NE NW</QCALL>)	Character	No	Yes
Q1 Largest	Character	Yes	No
Q2	Character	Yes	No
Q3	Character	Yes	No
Q4 Smallest	Character	Yes	No
Len_N_Side_Feet (REST tag is <NORTH_LINE>)	Number	Yes	Yes
Len_S_Side_Feet (REST tag is <SOUTH_LINE>)	Number	Yes	Yes
Len_E_Side_Feet (REST tag is <EAST_LINE>)	Number	Yes	Yes
Len_W_Side_Feet (REST tag is <WEST_LINE>)	Number	Yes	Yes
Acres (Approximate number of acres in the section)	Number	Yes	Yes
UTM_Northing (Y coordinate)	Number	Yes	Yes
UTM_Easting (X coordinate)	Number	Yes	Yes
UTM_Zone	Number	Yes	Yes
UTM_UNITS (UTM coordinates are in meters)	Character	Yes	No
Input_String (Echo of input parameters)	Character	Yes	No
Session_No (APEX session number)	Number	Yes	No
Timestamp (Session date and time)	Date	Yes	No
Record_No (Sequential result set record number)	Number	Yes	No
Errors (Error trapping message returned)	Character	Yes	Yes

A comparison chart of the output fields is depicted in the above table. For the most part the fields returned with the interactive page correspond to the fields returned from the web service. Yet, there are some instances where the XML tag name differs. The reason for the differences is to reduce the amount of network traffic. For instance, the interactive tool reports the quarter calls as four separate columns (Q1 Largest, Q2, Q3, and Q4 Smallest) in a grid while the REST service reports only one field named QCALL as a concatenation the four fields. The results can be seen in Example 1, a complete XML document returned by the REST service.

```

<?xml version="1.0"?>
<LEOWEB VERSION="11.00 [03/21/12]" PROCESS="LWREST11_01">
<RESULTS>
  <VERSION>11.00</VERSION>
  <LATITUDE>38.1</LATITUDE>
  <LONGITUDE>-98.1</LONGITUDE>
  <DATUM>NAD83</DATUM>
  <TRS>22S07W33</TRS>
  <CORNER>SE</CORNER>
  <NS>4910</NS>
  <EW>3678</EW>
  <SPOT>C</SPOT>
  <QCALL>SW NW NE NW</QCALL>
  <UTM_NORTHING>4217292.75742482</UTM_NORTHING>
  <UTM_EASTING>578910.958586044</UTM_EASTING>
  <UTM_ZONE>14</UTM_ZONE>
  <SECTION_INFO>
    <ACRES>645</ACRES>
    <BOUNDARY_LINES>
      <UNITS>FEET</UNITS>
      <NORTH_LINE>5285</NORTH_LINE>
      <SOUTH_LINE>5326</SOUTH_LINE>
      <EAST_LINE>5305</EAST_LINE>
      <WEST_LINE>5271</WEST_LINE>
    </BOUNDARY_LINES>
  </SECTION_INFO>
</RESULTS>
</LEOWEB>

```

Example 1. XML output from the LEOWEB REST Service.

Reporting Quarter Calls and Spot:

Quarter call subdivisions are reported left to right with the smallest first and the largest last. For a nominal section (one square mile) the smallest subdivision represents an area of 2.5 acres. For geographic to PLSS conversions, the “spot” within the smallest subdivision is estimated using a closest approximation algorithm. It represents the best fit of the actual coordinate to one of nine possible pre-designated positions. In figure 5 the geographic coordinate “X” is closest to the northwest (NW) corner of the subdivision. The nine fixed positions are 1) center, 2) northeast corner, 3) southeast corner, 4) southwest corner, 5) northwest corner, 6) center of the north line, 7) center of the east line, 8) center of the south line, and 9) center of the west line.

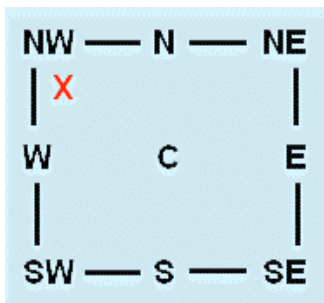


Figure 5. The spot is one of nine possible subdivision locations.

When entering TRS and Quarter calls (TRS Q Calls), the user specifies the spot (see above) and up to four levels of subdivision. A nominal section is divided as follows:

Level	Acres	Example
0.	- 640 acres	(i.e. Center of Township 1 South, Range 1 East, Section 1 or 01S01E01.)
1.	- 160 acres	(i.e. Center of NW quarter of 01S01E01)
2.	- 40 acres	(i.e. Center of SE NW quarter of 01S01E01)
3.	- 10 acres	(i.e. Center of SW SE NW quarter of 01S01E01)
4.	- 2.5 acres	(i.e. Center of SW SW SE NW quarter of 01S01E01)

Figure 6 shows location “X” spotted to three levels of subdivision. In LEOWEB “quarter calls” are reported “spot first” then from smallest to largest subdivision. In this example the q-call location could be identified as being the center of the southwest quarter (smallest) of the southeast quarter of the southwest quarter (largest) of Section 7, Township 9S, Range 5E.

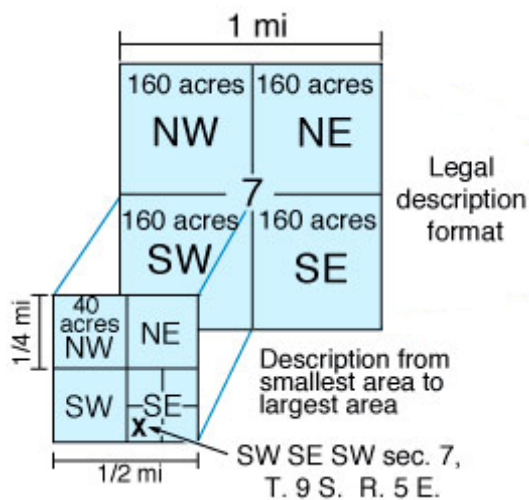


Figure 6. This image shows three levels of subdivision.

Note: LEOWEB reports on up to four levels of subdivision.

Four levels of subdivision are computed when converting geographic coordinates to TRS Calls. For example: A NAD83 lat/long coordinate of 38.41039961 and -99.720785 would approximate to a spot near the **center of the NW NE SW SE** subdivision of sec. 11, T. 19 S., R. 22 W. It should be noted that converting lat/long values to spot and quarter calls only produces a rough approximation of the actual location. In this example The “Center” spot is approximately 40 feet away from the actual location. Accuracy is improved by reporting TRS and footage descriptions if requirements permit.

Geodetic Datum:

When working with latitude and longitude coordinates, the North American Datum (NAD) serves as the horizontal geodetic control. This program allows the user to select from NAD27, NAD83, or the WGS84 datum. It is essential to record and specify the correct geodetic datum when capturing and converting data. Guessing or specifying the wrong datum results in calculation errors on the order of 10's of feet.

Footage Corner:

Footages refer to the offset distance from the location spot to the boundary lines of the section. A footage corner is used to identify which boundary lines are used in calculating the footage offset. If the southeast corner is specified (default), then the program calculates the offset distance from the south and east lines. Likewise the northwest corner would specify the offset with respect to the north and west boundary lines. Figure 7 depicts a location spotted 1750 feet north of the south line and 2000 feet west of the east line. The LEOWEB program uses a dropdown list to allow the user to change the reference corner for offset footages.

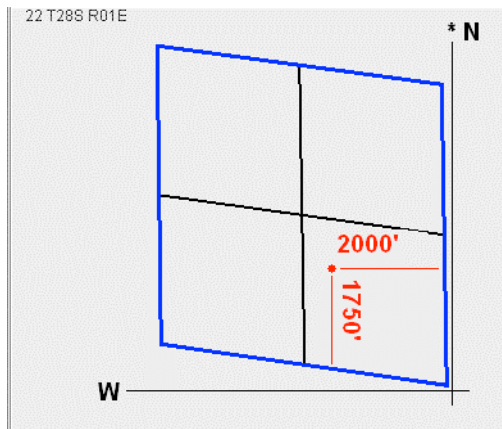


Figure 7. Spot footage 1750 ft north of south line and 2000 ft west of east line sec. 22, T. 28 S., R. 1 E.

Valid Kansas Coordinates:

LEOWEB is designed to report on locations that fall within the borders of Kansas. To aid the user, client-side data validation routines have been added that create warning messages when values fall outside a specified range. Figure 8 depicts an example of a warning message that is created by a data validation routine. The appearance of the message will vary depending on how the browser renders JavaScript messages. Google Chrome was used for this example

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Lat/Long (D.dddd) Lat/Long (DMS) Lat/Long (DM.mm) TRS_FT **TRS Q Calls** UTM Help About LEOWEB

Enter Township Range Section and Quarter Calls (start with largest subdivision, Q1, and work towards Q4.)

Datum: NAD83 Corner: SE Session No: -99999

Township: 1 South Range: 32 Range Direction: East Section: 1

SPOT: C Q4 (smallest): NONE Q3: NONE Q2: NONE Q1: NONE (largest)

Results String: Enter values above and c

The page at chasm.kgs.ku.edu says:
Warning: East Range values are between 1 and 25. West Range values are between 1 and 43.

Figure 8.Data validation warning message for an invalid entry.

The minimum and maximum values input parameters are summarized in Table 2.

Table 2

Conversion Option	Parameter	Minimum Value	Maximum Value
Decimal Degree Lat/Long to TRS NAD83/WGS84	Latitude	36.99300	39.9890
Decimal Degree Lat/Lon to TRS NAD83/WGS84	Longitude	-102.052000	-94.584000
Decimal Degree Lat/Lon to TRS NAD27	Latitude	36.9930 000	40.003200
Decimal Degree Lat/Lon to TRS NAD27	Longitude	-102.052000	-94.584000
Degree Minute Second Lat/Lon to TRS	Latitude Degrees	36	40
Degree Minute Second Lat/Lon to TRS	Latitude Minutes	0	59
Degree Minute Second Lat/Lon to TRS	Latitude Seconds	0.00	59.99
Degree Minute Second Lat/Lon to TRS	Longitude Degrees	-94	-102
Degree Minute Second Lat/Lon to TRS	Longitude Minutes	0	59
Degree Minute Second Lat/Lon to TRS	Longitude Seconds	0.00	59.99
Degree Decimal Minutes Lat/Lon to TRS	Latitude Degrees	36	40
Degree Decimal Minutes Lat/Lon to TRS	Latitude Minutes	0.0000	59.9999
Degree Decimal Minutes Lat/Lon to TRS	Longitude Degrees	-94	-102
Degree Decimal Minutes Lat/Lon to TRS	Longitude Minutes	0.0000	59.9999

Conversion Option	Parameter	Minimum Value	Maximum Value
TRS Conversions to Lat/Lon	Township	1	35
TRS Conversions to Lat/Lon	Range East	1	25
TRS Conversions to Lat/Lon	Range West	1	43
TRS Conversions to Lat/Lon	Section	1	36
TRS and Offset Footage to Lat/Lon	N-S Footage	0	5280*
TRS and Offset Footage to Lat/Lon	E-W Footage	0	5280*
UTM Coordinates to Lat/Lon	Northing	Not Validated	Not Validated
UTM Coordinates to Lat/Lon	Easting	Not Validated	Not Validated
UTM Coordinates to Lat/Lon	Zone	13	15

* Allows input greater than 5280 feet but throws a warning message.

Irregular Sections:

A section is an area $1/36^{\text{th}}$ of a township bounded by 1 square mile and covering 640 acres. Many sections in Kansas are smaller or larger than the prescribed nominal section. In fact very few, if any, sections are true square miles and less than 7 percent of Kansas sections actually cover an area equaling 640 acres. Figure 9 shows sec. 6, T. 35 S., R 8 E., encompassing 1616 acres. This irregular section is extremely large having east and west boundary lines of 5,284 and 5,285 feet, respectively, and north and south boundary lines of 13,316 and 13,327 feet in length. Fractional sections are frequently found along the borders and in areas with natural obstacles such as rivers. Users should be aware of irregular sections and problems associated with converting lat/long values to legal land descriptions.

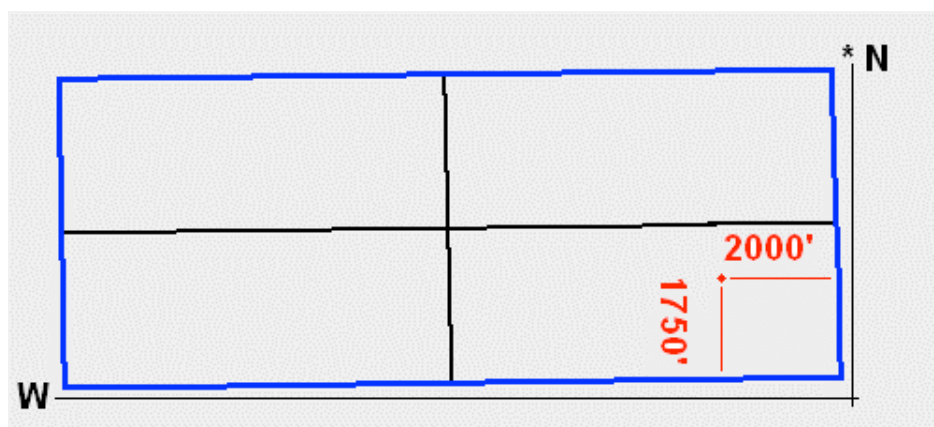


Figure 9. Irregular sec. 6, T. 35 S., R. 8 E. covers over 2 square miles of land. Note: Compare the footage spot to figure 7.

Unfortunately LEOWEB does not handle irregular sections very well. The southern boundary of sec. 36, T. 26 S., R. 20 E. (depicted in figure 10) is a good example of a section boundary that is not a straight line. In this example, land below the dashed line is still inside the section but not considered in the conversion calculation. This is because the calculation engine only considers the corner points of the section. Since LEOWEB uses an equal subdivision method, the program also has problems when subdividing irregular sections. The region around Fort Riley, Kansas, is a good example of an area with some extremely irregular sections. (See figure 11).

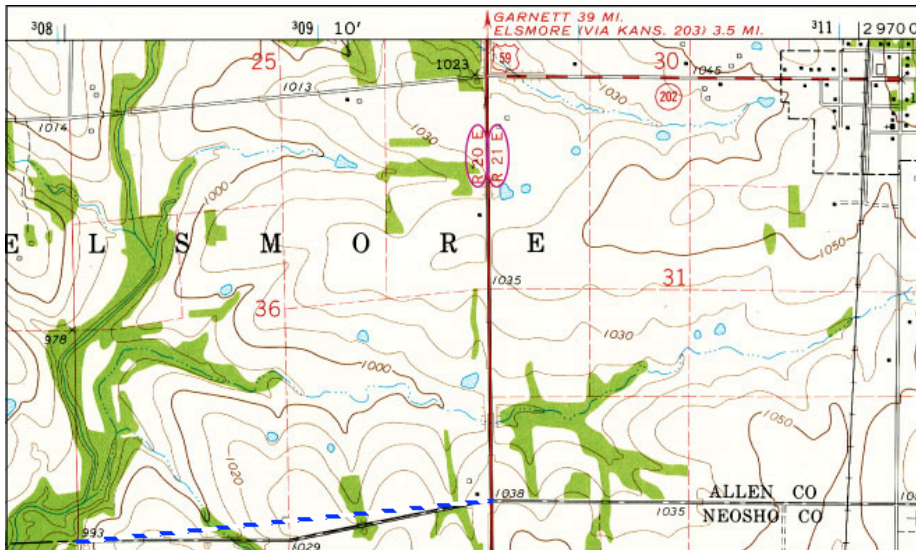


Figure 10. Irregular sec. 36, T. 26 S., R. 20 E. Note: the area below the dashed line is not considered in the LEOWEB conversion.

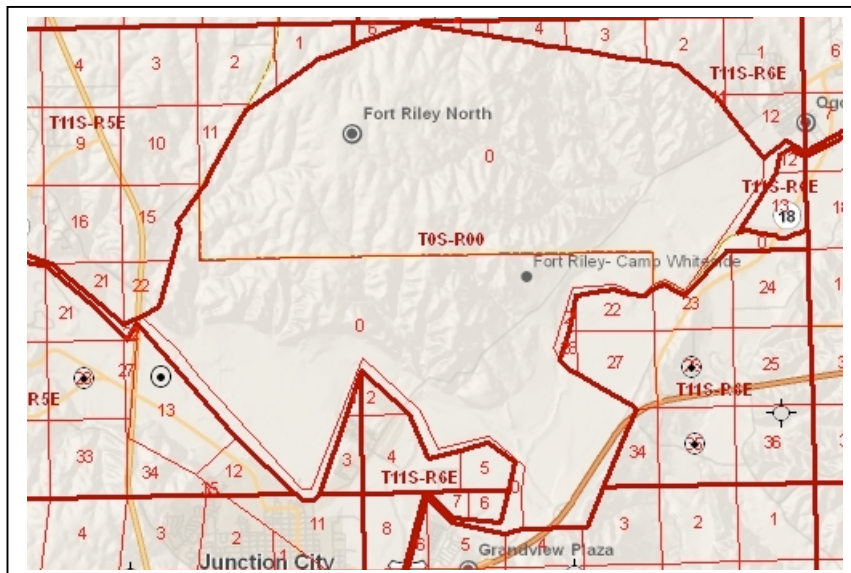


Figure 11. Irregular sections around the Fort Riley area.

Conversion Screens:

The following is a brief discussion on each of the six interactive web pages.

Enter Latitude and Longitude as Decimal Degree:

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Lat/Long (D.dddd) | Lat/Long (DMS) | Lat/Long (D.Mmm) | TRS_FT | TRS Q Calls | UTM | Help | About LEOWEB | REST Service

Enter Latitude and Longitude as Decimal Degrees

Datum: Corner: Session No: 4047211474667254

Latitude: Longitude:

Results String

Input Decimal Degrees Lat = 39.456789 Long = -97.876543
DD Lat: 39.456789 Long: -97.876543 Datum: NAD83
Kansas TRS: 07S05W09

Township: 7S Range : 5 W Section: 9
Spot Footages from SE Corner: 1759 N 1017 W
Spot: Center of NW SW NE SE

Section is approximately 640 acres
Length of north line = 5242 Ft
Length of south line = 5221 Ft
Length of east line = 5340 Ft

Submit

Q- Go Actions ▾


Latitude	Longitude	Datum	TRS	Footage NS	Footage EW	Footage Corner	Township	Township Direction	Range	Range Direction	Section
39.456789	-97.876543	NAD83	07S05W09	1759	1017	SE	7	S	5	W	9
39.45423	-97.880466	NAD83	07S05W09	832	2122	SE	7	S	5	W	9

Figure 12. Decimal Degree Lat/Long to TRS.

The option to convert decimal degree lat/lon values to TRS information (figure 12) is the default screen that appears on start-up. Data-validation routines force the values to conform to the minimum/maximum range specified in table 2.

Select the appropriate Datum and reference Corner from the dropdown lists and enter the desired latitude and longitude values prior to “clicking” on the **Submit** button. The conversion will be calculated and the results displayed in the Result String text area. The results are also added to the conversion list found just below the Interactive Report Menu. Appendix A provides an example of the “Result String” and the data structure for the conversion results table is found in Appendix B. Note: The same output format is used for all the interactive menu options.

Enter Latitude and Longitude as Degrees Minute Seconds:



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Lat/Long (D.dddd) **Lat/Long (DMS)** Lat/Long (DMmm) TRS_FT TRS O Calls UTM Help About LEOWEB REST Service

Enter Latitude and Longitude as Degrees Minutes and Seconds

Datum: NAD27 Corner: NE Session No 4047211474667254

Latitude Degrees: 39 Minutes: 23 Seconds: 24.10
Longitude Degrees: -96 Minutes: 56 Seconds: 46.15

Results String:

Input DMS Lat = 39 23' 24.1 Long = -96 56' 46.15
DD Lat: 39.390027 Long: -96.946152 Datum: NAD27
Kansas TRS: 08S04E02

Township: 8S Range : 4 E Section: 2
Spot Footages from NE Corner: 1505 S 1241 W
Spot: Center of NW NW SE NE


Section is approximately 651 acres
Length of north line = 5292 Ft
Length of south line = 5314 Ft
Length of east line = 5341 Ft

Latitude	Longitude	Datum	TRS	Footage NS	Footage EW	Footage Corner	Town- ship	Township Direction	Range	Range Direction	Section
39.390027	-96.946152	NAD27	08S04E02	1505	1241	NE	8	S	4	E	2
39.390027	-96.946152	NAD27	08S04E02	3838	1241	SE	8	S	4	E	2

Figure 13. Degrees Minute Second Lat/Long to TRS.

The second option converts lat/long values specified in degrees, minutes, and seconds to TRS. Figure 13 shows the data input fields and an example of the calculated results. Notice the datum has been set to calculate NAD27 values, and the reference corner has been set to report using the northeast reference corner.

Enter Latitude and Longitude as Degrees and Decimal Minutes:



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LEOWEB V11.000

Lat Long (D.ddddd)
Lat Long (DMS)
Lat Long (DM.mm)
TRS_FT
TRS O Calls
UTM
Help
About LEOWEB
REST Service

Enter Latitude and Longitude as Degrees Decimal Minutes

Datum: NAD83 Corner: SE Session No 4047211474667254

Latitude Degrees: Minutes:

Longitude Degrees: Minutes:

Results String

```

Input DMM Lat = 37 50.1234' Long = -100 10.5678'
DD Lat: 37.83539 Long: -100.17613 Datum: NAD83
Kansas TRS: 25S26W33

Township: 25S Range : 26 W Section: 33
Spot Footages from SE Corner: 3190 N 953 W
Spot: Center of NE SW SE NE

Section is approximately 647 acres
Length of north line = 5313 Ft
Length of south line = 5284 Ft
Length of east line = 5327 Ft
        
```

Submit


Q- Go Actions

Latitude	Longitude	Datum	TRS	Footage NS	Footage EW	Footage Corner	Township	Township Direction	Range	Range Direction	Section
37.83539	-100.17613	NAD83	25S26W33	3190	953	SE	25	S	26	W	33
37.83539	-100	NAD83	25S24W31	3451	2584	SE	25	S	24	W	31

Figure 14. Degrees Decimal Minutes Lat/Long to TRS.

Converting degrees decimal minutes to TRS is the third LEOWEB menu option. For this screen the user provides integer degrees and real numbers for the minute values. This option was added to accommodate readings from handheld GPS devices.

Enter Township Range Section and Footage values:



LEOWEB V11.000

Lat Long (D,ddd) | Lat Long (DMS) | Lat Long (DM,mm) | **TRS_FT** | TRS Q Calls | UTM | Help | About LEOWEB | REST Service

Enter Township Range Section and Footage values.

Datum: | Corner: | Session No: 2643283592265736

Township: | South | Range: | Range Direction: | Section:

Footage NS: | EW Footage: | Offset Direction: (North of the South section line and west of East section line.)

Results String
Input TRSFT = 05S05W08 Offset 2457 ft N of the South line, 2457 ft W of the East line.
DD Lat: 39.631546 Long: -97.902496 Datum: NAD83
Kansas TRS: 05S05W08

Township: 5S Range: 5 W Section: 8
Spot Footages from SE Corner: 2457 N 2457 W
Spot: Center of NW NW NW SE

Section is approximately 642 acres
Length of north line = 5276 Ft
Length of south line = 5299 Ft

Submit

| Go | Actions

Latitude	Longitude	Datum	TRS	Footage NS	Footage EW	Footage Corner	Township	Township Direction	Range	Range Direction	Section
39.631546	-97.902496	NAD83	05S05W08	2457	2457	SE	5	S	5	W	8
39.631599	-97.921277	NAD83	05S05W07	2457	2457	SE	5	S	5	W	7
39.646138	-97.921382	NAD83	05S05W06	2457	2457	SE	5	S	5	W	6

Figure 15. TRS and Offset Footage to Lat/Long.

Option 4 is selected when the user wants to convert TRS and footage information to latitude and longitude coordinates. The results are returned using the datum and reference corner specified in the dialog screen.

Enter Township Range Section and Quarter Calls:

LEOWEB V11.000

Lat Long (D,ddd) Lat Long (DMS) Lat Long (DMM) TRS_FT **TRS Q Calls** UTM Help About LEOWEB REST Service

Enter Township Range Section and Quarter Calls (start with largest subdivision, Q1, and work towards Q4.)

Datum: NAD27 Corner: SE Session No: 4165641416599927

Township: 5 South Range: 5 Range Direction: West Section: 5

SPOT: C Q4 (smallest): SE Q3: NE Q2: SW Q1: NE (largest)

Results String: Input TRSQC = 05S05W05
 DD Lat: 39.648667
 Kansas TRS: 05S05W05
 Township: 5S Range: 5W Section: 5
 Spot Footages from: 3420 N 1484 W
 Spot: Center of: SE
 Section is approximately 631 acres
 Length of north line = 5283 Ft
 Length of south line = 5276 Ft
 Length of east line = 5230 Ft

Submit


Q- Go Actions

Latitude	Longitude	Datum	TRS	Footage NS	Footage EW	Footage Corner	Township	Township Direction	Range	Range Direction	Section
39.648667	-97.898928	NAD27	05S05W05	3420	1484	SE	5	S	5	W	5
39.648673	-97.899249	NAD83	05S05W05	3420	1484	SE	5	S	5	W	5

Figure 16. TRS and Quarter Calls to Lat/Long.

The input panel for converting TRS and quarter call data to latitude and longitude coordinates offers more selection tools than any other interactive option. The user has the ability to specify the quarter call subdivision level and which “nine point spot” to calculate. When using the “TRS and Quarter Calls to Lat/Long” option, the user may find selecting the quarter calls from the dropdown lists a bit awkward. In order to enforce data validation rules, the screen was intentionally designed to require the user to enter the largest subdivision first, using the most right list (Q1). The user then works “right to left,” entering Q2, Q3, and Q4 as desired.

Enter UTM Northing Easting and Zone:



LEOWEB V11.000

Lat-Long (D,ddd)
Lat-Long (DMS)
Lat-Long (DM,mm)
TRS_FT
TRS O Calls
UTM
Help
About LEOWEB
REST Service

Enter UTM Northing, Easting and Zone

Datum: NAD83 Corner: SE Session No: 2832349311848743

Northing: Zone: ☐ 13 ☒ 14 ☐ 15

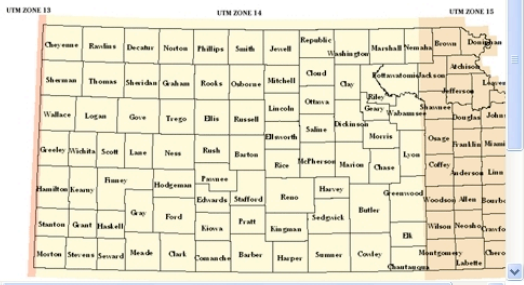
Easting:

Results String: Input UTM Northing = 4356826.01 Long = 580172.86
 DD Lat: 39.357168 Long: -98.069439 Datum: NAD83 TRS: 08S07W14
 Township: 8S Range: 7 W Section: 14
 Spot Footages from SE Corner: 2650 N 2648
 Spot: Center of
 Section is approximately 645 acres
 Length of north line = 5288 Ft
 Length of south line = 5306 Ft
 Length of east line = 5306 Ft

Q-

Zone

The UTM zones for Kansas are 13,14 and 15.



Latitude	Longitude	Datum	TRS	Footage NS	Footage EW	Footage Corner	Township	Township Direction	Range	Range Direction	Section
39.357168	-98.069439	NAD83	08S07W14	2650	2648	SE	8	S	7	W	14

Figure 17. UTM Coordinates to Lat/Long.

When converting UTM coordinates, specifying the correct geodetic datum and UTM zone is important. Zone 14 is the default option, but the state of Kansas includes zones 13, 14, and 15. In this example the help feature for the “Zone” radio buttons has been activated by clicking on the word “Zone.” (Help is available on all LEOWEB objects.)

Using the Interactive Report Tools:

When coordinates are converted in LEOWEB, the results are added to a database table that is displayed as a grid in the lower region of the web page. As mentioned earlier, the layout and content of the grid can be customized using the APEX interactive report tools. Perhaps the most important feature is the ability to download the dataset to the client computer. This is done by selecting the “Actions” button and then choosing the download feature. (Figure 18.) The user will be prompted to save the data as a CSV file or in HTML format.

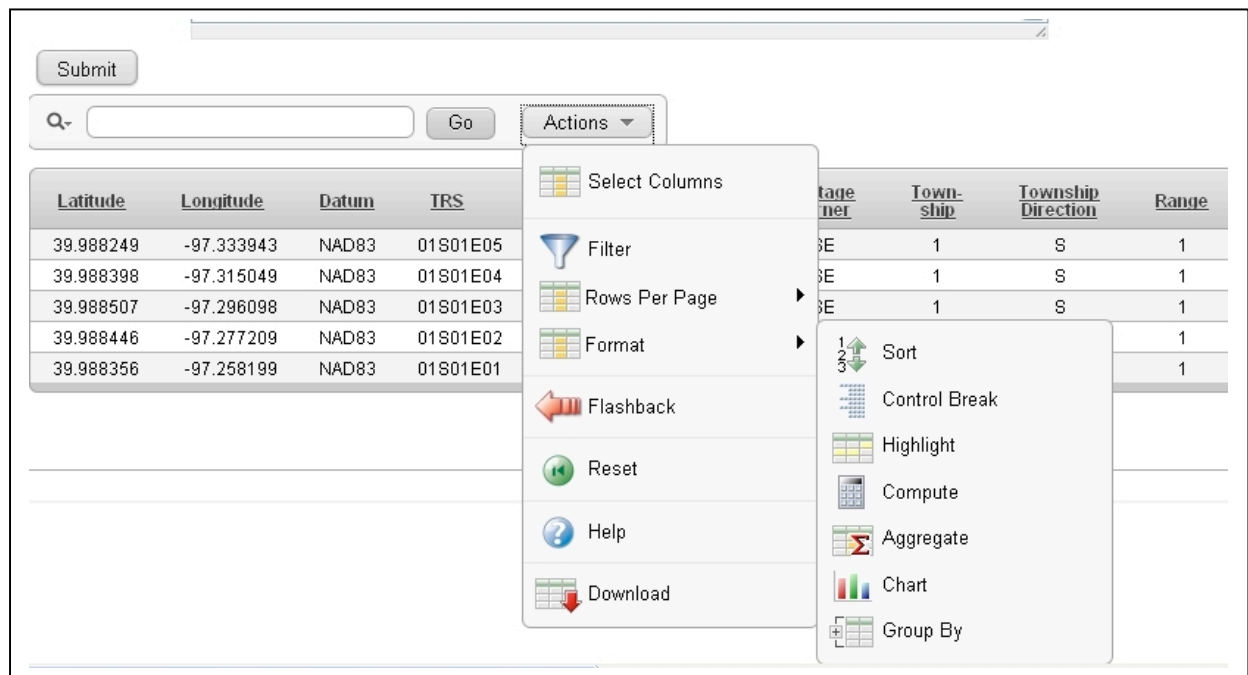


Figure 18. Using the Interactive Report the data can be downloaded to the client computer.

Other interactive report features include the ability to search on data fields, manage the columns that are displayed, filter the dataset, control the number of records displayed on a page, and re-format the layout. The “Format” menu option offers several sub-menu options to further enhance the report. There is also a “Reset” button that will allow the user to undo the format settings and the return to the default screen.

Searching Columns:

To find a particular value in one of the columns, simply click on the “Search” icon and select the desired data column from the dropdown list (Figure 19). After doing so, enter the value to search for in the input text box and press the “Go” button.

Using the Interactive Report Tools (continued):

The screenshot shows the Interactive Report Tools interface. At the top, there is a "Submit" button. Below it, a search bar with a magnifying glass icon and a "Go" button. To the right of the search bar is an "Actions" dropdown menu. A sidebar on the left lists columns: "All Columns", "Latitude", "Longitude", "Datum", "TRS", "Footage NS", "Footage EW", "Footage Corner", "Town- ship", "Township Direction", and "Range". The "Datum" column is selected, and a table of results is displayed. The table has columns: "Datum", "TRS", "Footage NS", and "Footage EW".

Datum	TRS	Footage NS	Footage EW
AD27	05S15W05	3265	
AD83	05S15W05	3265	
AD83	05S15W04	1478	
AD27	05S15W04	1478	
AD27	05S15W03	1897	
AD83	05S15W03	1897	
AD27	05S15W02	987	
AD83	05S15W02	987	
AD27	05S15W01	1234	
AD83	05S15W01	1234	

Figure 19. Using the Interactive Report to search for a value in a column.

The “Search” action serves as a simple filter on the dataset. If a search fails to find any values it returns an empty set; otherwise, it only displays records that meet the search criteria. When a search or filter has been enabled an icon that resembles a funnel is displayed in addition to the records. Figure 20 shows the results of searching for “NAD27” records. (Note the funnel icon and words “Datum contains NAD27” just above the grid.)

The screenshot shows the Interactive Report Tools interface with a search filter applied. At the top, there is a "Submit" button. Below it, a search bar with a magnifying glass icon and a "Go" button. To the right of the search bar is an "Actions" dropdown menu. Below the search bar, there is a funnel icon and the text "Datum contains 'NAD27'" with a green checkmark and a red X icon. Below this, a table of results is displayed. The table has columns: "Latitude", "Longitude", "Datum", "TRS", "Footage NS", "Footage EW", "Footage Corner", and "Town- ship".

Latitude	Longitude	Datum	TRS	Footage NS	Footage EW	Footage Corner	Town- ship
39.649419	-99.033127	NAD27	05S15W05	3265	1255	SE	5
39.644484	-99.018479	NAD27	05S15W04	1478	2414	SE	5
39.645605	-99.003371	NAD27	05S15W03	1897	3426	SE	5

Figure 20. A funnel-shaped icon is displayed when a filter is enabled.

The user can nest searches. Additional icons are displayed as the searches are nested. To undo a search you can click on the “red X” over the funnel or select the “Reset” option.

Selecting Columns:

Appendix B lists the fields that are displayed in the results table. The user will notice that some of these values are repeated. For instance the Township, Range, and Section fields are reported as individual columns as well as concatenated into a field called “TRS.” Although redundant, this format was chosen to simplify efforts for the end user.

The interactive report tool allows you to hide unwanted columns as well as re-order the list. This is accomplished by selecting “Actions,” then the “Select Columns” menu option. (Figure 21.)

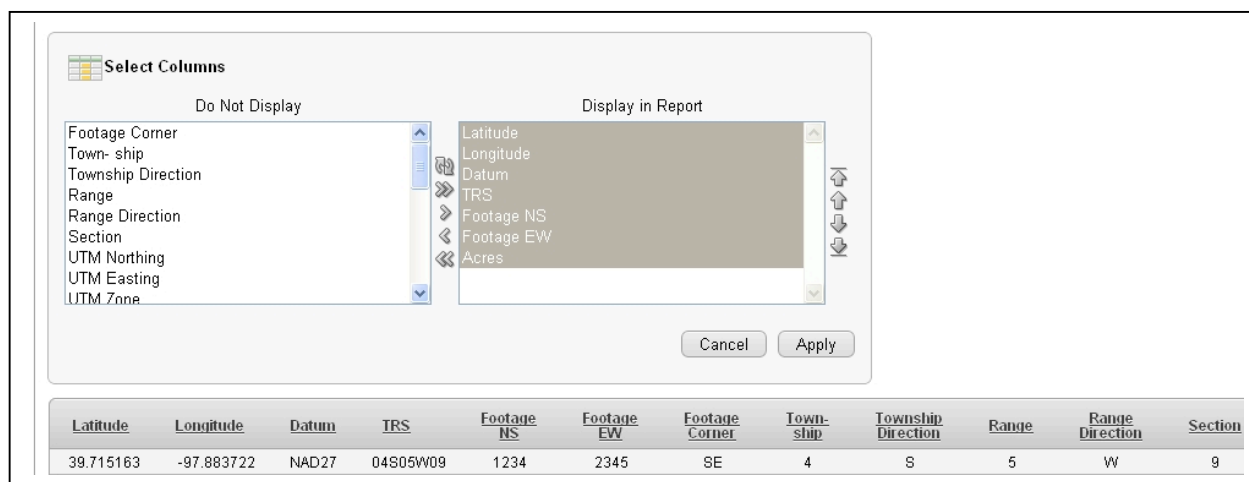


Figure 21. The columns can be removed or added to the report display.

Use the navigation arrows found in the middle of the screen to move columns from the “Do Not Display” list to the “Display in Report” area. You can order the columns from left (top) to right (bottom) by using the “up-down” arrows on the far right side. Pressing the “Apply” button refreshes the screen, showing only the selected columns. (Figure 22.)



Figure 22. Here the user has chosen to limit the number of columns displayed in the report.

Advanced Filtering:

The “Filter” option offers more advanced filtering possibilities than the simple search. Like the simple search the user selects the columns of interest from a dropdown list. The big difference between the two methods is the number of comparison operators available to the user. The simple search only performs an “is equal” comparison where as the “Filter” option offers many more operators to choose from. (Figure 23.) These filters can be nested.

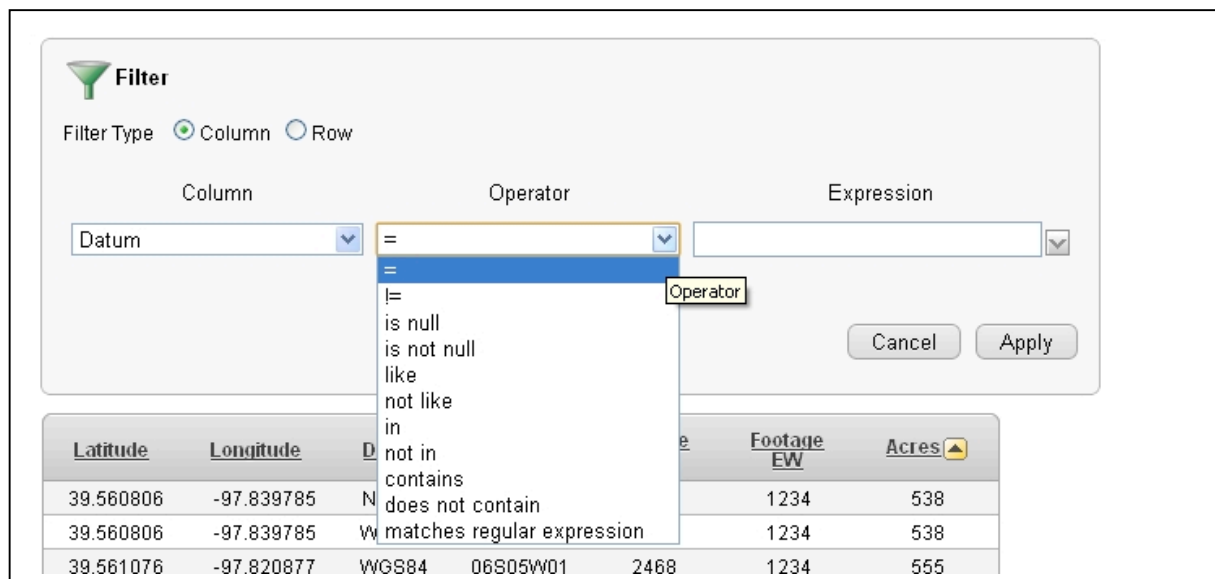


Figure 23. The FILTER option offers several comparison operators.

Formatting Layout:

APEX offers a rich set of interactive formatting tools allowing the user to further modify the report layout. These features include the ability to sort records, set up control breaks, define record highlighting, add computed columns, perform aggregate computations, chart values, and group data records. These tools are similar to what a user would find in a spreadsheet program. This document gives simple examples on how to sort columns and perform computations. The user is encouraged to experiment with the various tools as the possibilities are numerous.

Sorting by Columns:

For this example we have used the “Select Columns” option to limit the display to latitude, longitude, datum, TRS, section, and acres. From the “Actions” menu select “Format” and then “Sort.” This feature allows the user to select the column to sort on, specify ascending or descending, and how to handle null values. Null value options are “Nulls Always Last” and “Nulls Always First.” Figure 24 shows the sort utility screen.

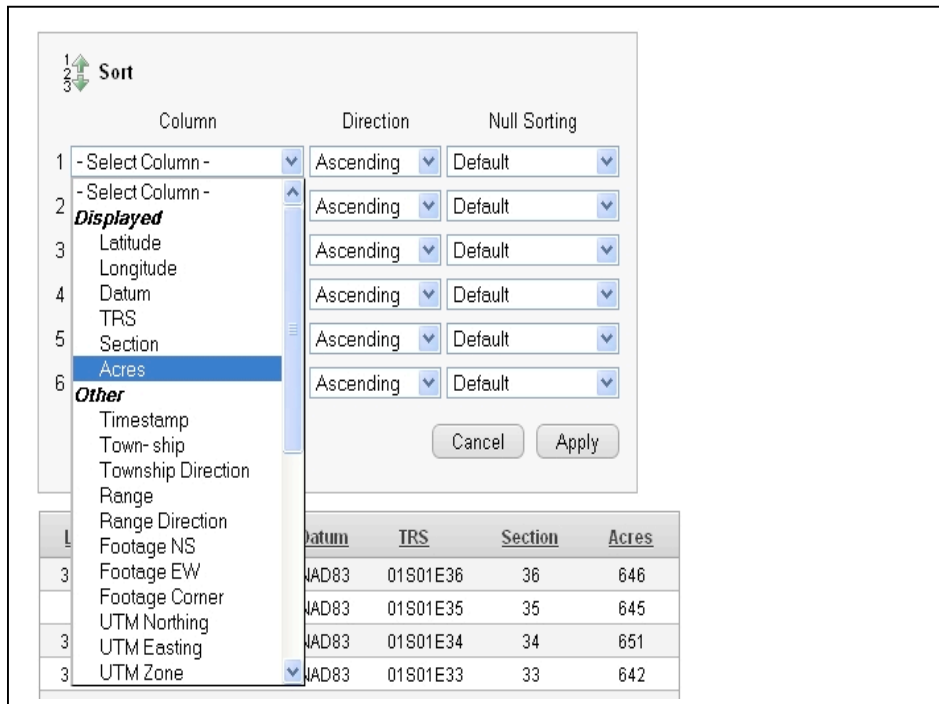


Figure 24. The SORT option offers up to six levels of sorting.

The sort feature allows for up to six levels of sorting. The user can sort on the hidden columns as well as the ones that are displayed. In Figure 25 we have sorted on acres and sections in ascending order. The “Highlight” option has been used to emphasize sections having 610 acres. The “Control Break” and “Group By” utilities operate in a similar fashion to the sort utility.

☐ Acres = 610 ☒ ☐

Latitude	Longitude	Datum	TRS	Section	Acres
39.988446	-97.277209	NAD83	01S01E02	2	607
39.987995	-97.352864	NAD83	01S01E06	6	608
39.944424	-97.353055	NAD83	01S01E19	19	609
39.988356	-97.258199	NAD83	01S01E01	1	610
39.929876	-97.353016	NAD83	01S01E30	30	610
39.915342	-97.352926	NAD83	01S01E31	31	610
39.988507	-97.296098	NAD83	01S01E03	3	611
39.973524	-97.35279	NAD83	01S01E07	7	613

Figure 25. Records sorted by acres and sections, highlighting sections having 610 acres.

Creating a Computed Column:

The “Compute” option allows the user to add computed columns to the report. Computations can be performed on numeric, string, and date fields. The Online Help feature of the interactive reports tool gives additional information on how to create computed fields. In this example we create a computed column as a string that reports the quarter calls as a concatenated text string.

From the “Actions” menu select “Format” and then “Compute.” The compute utility dialog will appear as shown in Figure 26.

Compute

Computation: QCall

Column Heading: QCall Format Mask:

Computation Expression: `trim(AL || ' ' || AK || ' ' || AJ || ' ' || AI)`

Columns	Keypad	Function
AH. Spot	() '	ABS
AL. Q1 (Largest)	7 8 9 -	ADD_MONTHS
AJ. Q2	4 5 6 +	CASE
AK. Q3	1 2 3 *	CEIL
AL. Q4 (Smallest)	0 . /	CHR
AM. Errors	space .	COALESCE

Create a computation using column aliases.

Examples:


1. (B+C)*100
2. INITCAP(B)||', '||INITCAP(C)
3. CASE WHEN A = 10 THEN B + C ELSE B END

Cancel Delete Apply

Figure 26. Interactive Report Tool for creating computed columns.

A computed field is created by assigning a column heading to the new column and adding a computational expression in the text area. The tool features lists of available columns and functions that can be applied. Note the columns are not entered by their name but by an alias (i.e. Q2 is AJ). For our quarter call string we have named the new column “QCall” and used the following computational string: **trim(AL || ' ' || AK || ' ' || AJ || ' ' || AI)**. Click the “Apply” button to add the new computed column display. (Figure 27.)

Creating a Computed Column (continued):



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Lat/Long (D.dddd)	Lat/Long (DMS)	Lat/Long (DM.mmm)	TRS_FT	TRS Q Calls	UTM	Help
-------------------	----------------	-------------------	--------	-------------	-----	------

Enter Latitude and Longitude as Decimal Degrees

Datum: NAD83 Corner: SE Session No: 2832349311848743

Latitude: 38.250123

Longitude: -98.250123

Results String

Input Decimal Degrees Lat = 38.250123 Long = -98.250123
DD Lat: 38.250123 Long: -98.250123 Datum: NAD83
Kansas TRS: 21S08W06

Township: 21S Range : 8 W Section: 6
Spot Footages from SE Corner: 1455 N 4524 W
Spot: Center of SE SW NW SW

Section is approximately 625 acres
Length of north line = 5094 Ft
Length of south line = 5140 Ft
Length of east line = 5338 Ft

Latitude	Longitude	Datum	TRS	Footage NS	Footage EW	Acres	QCall
38.250123	-98.250123	NAD83	21S08W06	1455	4524	625	SE SW NW SW
38.240123	-98.240123	NAD83	21S08W07	3170	1679	627	NW SE SW NE
38.230123	-98.230123	NAD83	21S08W17	4824	4076	638	SE NE NW NW
38.220123	-98.220123	NAD83	21S08W17	1129	1210	638	NW NW SE SE
38.210123	-98.210123	NAD83	21S08W21	2726	3617	641	SE SW SE NW
38.190123	-98.190123	NAD83	21S08W27	669	3162	644	SW NE SE SW
38.180123	-98.180123	NAD83	21S08W34	2337	286	650	NE NE NE SE
38.170123	-98.170123	NAD83	22S08W02	3982	2692	643	NE NE SE NW
38.160123	-98.160123	NAD83	22S08W01	309	5138	649	SW SW SW SW
38.150123	-98.150123	NAD83	22S08W12	1914	2256	645	NE SW NW SE
38.140123	-98.140123	NAD83	22S07W18	3613	4464	672	SE NW SW NW

Figure 27. Interactive Report Tool showing the “QCall” computed column.

LEOWEB REST Service:

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LEOWEB V11.000

Lat Long (D.dddd) Lat Long (DMS) Lat Long (DM.mmm) TRS_FT TRS Q Calls UTM Help About LEOWEB **REST Service**

REST Service

LEOWEB RESTful WEB SERVICE

The LEOWEB project offers a REST web service for transferring LEO data via a URI in HTTP. This service runs independently of the interactive version of LEOWEB but offers the same conversion

Click on the example links to view returned format.

1. Decimal Degree Latitude and Longitude to Township Range and Section
Example: http://chasm.kgs.ku.edu/apex/leoweb.lwrest11_01.ConvertLLDEG?Datum=NAD83&Latitude=38.1&Longitude=98.1&Corner=SE
2. Degrees Minutes Seconds Lat/Lon to Township Range and Section
Example: http://chasm.kgs.ku.edu/apex/leoweb.lwrest11_01.ConvertLLDMS?Datum=NAD83&LatDeg=38&LatMin=45&LatSec=30&LonDeg=98&LonMin=45&LonSec=30&Corner=SE
3. Degrees Decimal Minutes Lat/Lon to Township Range and Section
Example: http://chasm.kgs.ku.edu/apex/leoweb.lwrest11_01.ConvertLLDMm?Datum=NAD83&LatDeg=38&LatMmm=45.5&LonDeg=98&LonMmm=45.5&Corner=SE
4. Township, Range, Section and Footage Offsets to Latitude and Longitude
Example: http://chasm.kgs.ku.edu/apex/leoweb.lwrest11_01.ConvertTRSFT?Datum=NAD83&TRS=10S17W12&Corner=SE&FT_NS=0&FT_EW=0
5. Township, Range, Section and Quarter Calls to Latitude and Longitude
Example: http://chasm.kgs.ku.edu/apex/leoweb.lwrest11_01.ConvertTRSQC?Datum=NAD83&TRS=10S17W12&QCall=NWNESE&Spot=C&Corner=SE
6. UTM coordinates Township Range and Section
Example: http://chasm.kgs.ku.edu/apex/leoweb.lwrest11_01.ConvertUTM?Datum=NAD83&Northing=4217292.76&Easting=578910.96&Zone=14&Corner=SE

Figure 28. LEOWEB help page for the REST Service.

REST is an acronym for REpresentational State Transfer. It is a software architecture designed to permit distributed computing over networks. Because of its simplicity, it has become a popular method for running programs over the World Wide Web. Generally speaking, resources are accessed by making HTTP requests to a web service through the use of a URL (uniform resource locator). Resources are then made available or acted upon in a format that is appropriate for the resource. It could be a downloaded image, the delivery of an XML document, or perhaps some other action, such as the execution of an automated process.

The LEOWEB offers a READ-ONLY service that performs the same coordinate conversions as the interactive tool. Each conversion method has its own URL format consisting of a resource name along with query parameters. The HTTP request can be invoked programmatically (See appendix D for example code). Doing so will result in the generation of an XML document derived from the LEO calculation engine. The document is then returned to the calling program where it can be parsed. Examples, for each of the URL formats, are presented on the **REST Service** help page (Figure 28). The user can click on the links to get an idea of the information that is returned to the calling program. Because the links may change over time, a best practice would be to get the latest URL's from the website

1. – Example of URL for converting decimal degree latitude and longitude.

http://chasm.kgs.ku.edu/apex/leoweb.lwrest11_01.ConvertLLDEG?Datum=NAD83&Latitude=38.1&Longitude=-98.1&Corner=SE

The question mark (?) is used to separate the resource name from the query variables. For converting decimal degree latitude and longitude coordinates, use the resource name of “http://chasm.kgs.ku.edu/apex/leoweb.lwrest11_01.ConvertLLDEG” along with the query variables: **Datum, Latitude, Longitude, and Corner**. Values are assigned to each variable using the equal sign (=). The ampersand (&) is used to separate variables.

i.e. Datum=NAD83&Latitude=38.1&Longitude=-98.1&Corner=SE

2. – Example of URL for converting Degrees Minutes Seconds latitude and longitude.

http://chasm.kgs.ku.edu/apex/leoweb.lwrest11_01.ConvertLLDMS?Datum=NAD83&LatDeg=38&LatMin=45&LatSec=30&LonDeg=98&LonMin=45&LonSec=30&Corner=SE

The question mark (?) is used to separate the resource name from the query variables. For converting Degree Minutes and Seconds latitude and longitude coordinates, use the resource name of “http://chasm.kgs.ku.edu/apex/leoweb.lwrest11_01.ConvertLLDMS” along with the query variables: **Datum, LatDeg, LatMin, LatSec, LonDeg, LonMin, LonSec, and Corner**. Values are assigned to each variable using the equal sign (=). The ampersand (&) is used to separate variables.

i.e. Datum=NAD83&LatDeg=38&LatMin=45&LatSec=30&LonDeg=98&LonMin=45&LonSec=30&Corner=SE

3. – Example of URL for converting Degrees and Decimal Minute latitude and longitude.

http://chasm.kgs.ku.edu/apex/leoweb.lwrest11_01.ConvertLLDMm?Datum=NAD83&LatDeg=38&LatMmm=45.5&LonDeg=98&LonMmm=45.5&Corner=SE

The question mark (?) is used to separate the resource name from the query variables. For converting Degrees Decimal Minutes latitude and longitude coordinates, use the resource name of “http://chasm.kgs.ku.edu/apex/leoweb.lwrest11_01.ConvertLLDMm” along with the query variables: **Datum, LatDeg, LatMmm, LonDeg, LonMmm, and Corner**. Values are assigned to each variable using the equal sign (=). The ampersand (&) is used to separate variables.

i.e. Datum=NAD83&LatDeg=38&LatMmm=45.5&LonDeg=98&LonMmm=45.5&Corner=SE

4. – Example of URL for converting Township, Range, Section, and Footage Offsets.

http://chasm.kgs.ku.edu/apex/leoweb.lwrest11_01.ConvertTRSFT?Datum=NAD83&TRS=10S17W12&Corner=SE&FT_NS=0&FT_EW=0

The question mark (?) is used to separate the resource name from the query variables. For converting Degree Minutes and Seconds, latitude and longitude coordinates use the resource name of “http://chasm.kgs.ku.edu/apex/leoweb.lwrest11_01.ConvertTRSFT” along with the query variables: **Datum, TRS, Corner, FT_NS, and FT_EW**. Values are assigned to each variable using the equal sign (=). The ampersand (&) is used to separate variables.

i.e. Datum=NAD83&TRS=10S17W12&Corner=SE&FT_NS=0&FT_EW=0

5. – Example of URL for converting Township, Range, Section, and Quarter Calls.

http://chasm.kgs.ku.edu/apex/leoweb.lwrest11_01.ConvertTRSQC?Datum=NAD83&TRS=10S17W12&QCall=NWNESWSE&Spot=C&Corner=SE

The question mark (?) is used to separate the resource name from the query variables. For converting Degree Minutes and Seconds, latitude and longitude coordinates use the resource name of “http://chasm.kgs.ku.edu/apex/leoweb.lwrest11_01.ConvertTRSQC” along with the query variables: **Datum, TRS, QCall, Spot, and Corner**. Values are assigned to each variable using the equal sign (=). The ampersand (&) is used to separate the variables.

i.e. Datum=NAD83&TRS=10S17W12&QCall=NWNESWSE&Spot=C&Corner=SE

6. – Example of URL for converting UTM coordinates.

http://chasm.kgs.ku.edu/apex/leoweb.lwrest11_01.ConvertUTM?Datum=NAD83&Northing=4217292.76&Easting=578910.96&Zone=14&Corner=SE

The question mark (?) is used to separate the resource name from the query variables. For converting Degree Minutes and Seconds, latitude and longitude coordinates use the resource name of “http://chasm.kgs.ku.edu/apex/leoweb.lwrest11_01.ConvertUTM” along with the query variables: **Datum, Northing, Easting, Zone, and Corner**. Values are assigned to each variable using the equal sign (=). The ampersand (&) is used to separate the variables.

i.e. Datum=NAD83&Northing=4217292.76&Easting=578910.96&Zone=14&Corner=SE

Appendix A

LEOWEB 11.0 Interactive Conversion:

The conversion results are calculated and displayed in the text area labeled “Results String.” The following is an example of the output for the Decimal Degree Latitude and Longitude conversion to Township, Range, and Section.

Option: (Degree Decimal Degree Lat/Long to TRS)

Input :Decimal Degrees Latitude = 38.150025 Longitude = -99.357159
Datum = NAD83, Reference Corner = SE

Text Area Results Display:

Input Decimal Degrees Lat = 38.150025 Long = -99.357159
DD Lat: 38.150025 Long: -99.357159 Datum: NAD83
Kansas TRS: 22S19W12

Township: 22S Range : 19 W Section: 12
Spot Footages from SE Corner: 1365 N 1970 W
Spot: Center of SW SE NW SE

Section is approximately 646 acres
Length of north line = 5303 Ft
Length of south line = 5282 Ft
Length of east line = 5321 Ft
Length of west line = 5299 Ft
UTM's calculated using NAD83
Northing: 4222521.06 Easting: 468706.33 Zone: 14

Appendix B

LEOWEB 11.0 Interactive Conversion:

In addition to output being displayed in the “Results String” text area, output is also added to a database table that can be downloaded to the client computer. This information is displayed in the grid area of the web page and can be modified using the Interactive Report Actions tool.

Display Grid:

```
CREATE TABLE "CONRESULTS"
(
    "TRS" VARCHAR2(8),
    "LATITUDE" NUMBER,
    "LONGITUDE" NUMBER,
    "DATUM" VARCHAR2(5),
    "TOWNSHIP" NUMBER(2,0),
    "TOWNSHIP_DIRECTION" VARCHAR2(1),
    "RANGE" NUMBER(2,0),
    "RANGE_DIRECTION" VARCHAR2(1),
    "SECTION" NUMBER(2,0),
    "FOOTAGE_NS" NUMBER,
    "FOOTAGE_EW" NUMBER,
    "FOOTAGE_CORNER" VARCHAR2(2),
    "SPOT" VARCHAR2(2),
    "Q1_LARGEST" VARCHAR2(2),
    "Q2" VARCHAR2(2),
    "Q3" VARCHAR2(2),
    "Q4_SMALLEST" VARCHAR2(2),
    "LEN_N_SIDE_FEET" NUMBER,
    "LEN_S_SIDE_FEET" NUMBER,
    "LEN_E_SIDE_FEET" NUMBER,
    "LEN_W_SIDE_FEET" NUMBER,
    "ACRES" NUMBER,
    "UTM_NORTHING" NUMBER,
    "UTM_EASTING" NUMBER,
    "UTM_ZONE" NUMBER,
    "UTM_UNITS" VARCHAR2(8),
    "INPUT_STRING" VARCHAR2(96),
    "SESSION_NO" NUMBER,
    "TIMESTAMP" DATE,
    "RECORD_NO" NUMBER,
    "ERRORS" VARCHAR2(4000)
) ;
```

Appendix C

LEOWEB REST Service:

Example of XML returned.

```
<?xml version="1.0" ?>
  <LEOWEB VERSION="11.00 [03/21/12]" PROCESS="LWREST11_01">
    <RESULTS>
      <VERSION>11.00</VERSION>
      <LATITUDE>38.1</LATITUDE>
      <LONGITUDE>-98.1</LONGITUDE>
      <DATUM>NAD83</DATUM>
      <TRS>22S07W33</TRS>
      <CORNER>SE</CORNER>
      <NS>4910</NS>
      <EW>3678</EW>
      <SPOT>C</SPOT>
      <QCALL>SW NW NE NW</QCALL>
      <UTM_NORTHING>4217292.75742482</UTM_NORTHING>
      <UTM_EASTING>578910.958586044</UTM_EASTING>
      <UTM_ZONE>14</UTM_ZONE>
      <SECTION_INFO>
        <ACRES>645</ACRES>
        <BOUNDARY_LINES>
          <UNITS>FEET</UNITS>
          <NORTH_LINE>5285</NORTH_LINE>
          <SOUTH_LINE>5326</SOUTH_LINE>
          <EAST_LINE>5305</EAST_LINE>
          <WEST_LINE>5271</WEST_LINE>
        </BOUNDARY_LINES>
      </SECTION_INFO>
    </RESULTS>
  </LEOWEB>
```

Example of XML returned when an error occurs.

```
<?xml version="1.0" ?>
  <LEOWEB VERSION="11.00 [03/21/12]" PROCESS="LWREST11_01">
    <ERROR>
      <Routine>LoadCorner()</Routine>
      <Message>Legal values are NW,NE,SE,SW</Message>
      <Parameter>Corner</Parameter>
      <Value>XE</Value>
    </ERROR>
  </LEOWEB>
```


Appendix D

JAVA example of a program that calls the LEOWEB REST Service.

```
import java.io.*;
import java.net.*;

public class leoweb_rest_test
{
    /**
     * Example of accessing LEOWEB REST service
     */

    public static void main(String[] args)
    {

        // Step 1. Build the URL request string
        String urlRequestString = new String(
            "http://chasm.kgs.ku.edu/apex/leoweb.lwrest11_01.ConvertLLDEG?" +
            "Datum=NAD83&Latitude=38.1&Longitude=-98.1&Corner=SE");

        // Step 2. try catch block
        try
        {
            // Step 3. Create a URL resource pointer
            URL myURL = new URL(urlRequestString);

            // Step 4. Create an HttpURLConnection instance to make the request
            HttpURLConnection myConn = (HttpURLConnection) myURL.openConnection();

            // Step 5. Create a Buffer Reader to read in the response of the request
            BufferedReader myBuffer = new
                BufferedReader(new InputStreamReader(myConn.getInputStream()));

            // Step 6. Create a string buffer for building the XML document
            StringBuilder myXMLDoc = new StringBuilder();

            // Step 7. Create a string to capture the input characters
            String myLine;

            // Step 8. Append the characters from the read buffer to the document
            while ((myLine = myBuffer.readLine()) != null)
            {
                myXMLDoc.append(myLine);
            }

            // Step 9 close buffer and connection
            myBuffer.close();
            myConn.disconnect();

            // Step 10 print the XML document
            System.out.println(myXMLDoc.toString());

        }
        catch (IOException e)
        {
            // print the exception message
            System.out.println(e.toString() );
        }
    }
}
```

}

References:

Good, D. I., 1964, Mathematical conversion of section, township, and range notation to Cartesian coordinates: State Geological Survey of Kansas, Bulletin 170, pt. 3, 30 p.

Morgan, C. O., and McNellis, M. J., 1969, FORTRAN IV Program, KANS, for the Conversion of General Land Office Locations to Latitude and Longitude Coordinates: State Geological Survey of Kansas, Special Distribution Pub. 42, 24 p.

Thompson, M. M., 1979 Maps for America: U.S. Geological Survey, p. 252.

Ross, C. G., 1989, LEO-conversion between legal and geographic reference systems in Kansas: Kansas Geological Survey, Open-file Report 89-10, 9 p.

Suchy, D. R., 2002, The public land survey system in Kansas: Kansas Geological Survey, Public Information Circular 20, 4 p.; available online at http://www.kgs.ku.edu/Publications/pic20/pic20_1.html (accessed 06/27/2012).

Gagnon, G. F., 2008, LEO Version 7.0 User Manual: Kansas Geological Survey, Open-file Report 2008-24, 20 p.; available online at http://www.kgs.ku.edu/software/LEO/LEO_07_UserManual_OFR_2008-24.pdf (accessed 06/27/2012).

Oracle® Application Express Installation Guide, Release 4.1, Part Number E21673-04, http://docs.oracle.com/cd/E23903_01/doc/doc.41/e21673/pre_require.htm#autoId2, (accessed 06/27/2012).

W3C, XML Essentials, <http://www.w3.org/standards/xml/core> (accessed 06/27/2012).

W3School, XML Tutorial, <http://www.w3schools.com/xml/default.asp> (accessed 06/27/2012).

IBM, RESTful Web services: The basics, <http://www.ibm.com/developerworks/webservices/library/ws-restful/> (accessed 06/27/2012).